Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

232
.A8 83
no. 3

AIC-158

UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural and Industrial Chemistry
Agricultural Chemical Research Division
2100 Robert E. Lee Boulevard
New Orleans, Louisiana

REPORT OF STUDIES ON UNIFORMITY OF QUALITY OF BEET SUGARS, NO. XXVI

I. Chemical and Physical Studies on Beet Sugars of the 1946 Campaign, by C. A. Fort and S. Byall.

II. Biological Studies of the 1946 Beet Sugars, by H. H. Hall and Dorothea J. Teunisson.

July 1947

LIBRARY
CURRENT SERIAL RECORD
JUL 15 1947
U. S. DEPARTMENT OF AGRICULTURE

REPORT NUMBER XXVI

A Review of the Operating Data of the 1946 Campaign and of Chemical, Physical and Biological Studies on the Sugars Produced.

PREFACE

With 74 factories in operation the campaign of 1946 approached normal production. The non-Steffen operation of nine Steffen equipped factories was continued. All but one factory submitted composite sugar samples which have been critically examined. Four additional sugars were included in the studies, namely numbers 4606B, 4656E, 4694 and 4695. The last two were not used in preparing the general averages.

In Part I are presented (1) a tabular summary and a discussion of the operating data supplied by the sugar factories and (2) the chemical and physical data obtained on the sugars. In Part II are summarized the biological data in respect to thermophilic and mesophilic contaminants of the sugars.

No special studies of sugar quality factors or analytical methods are given this year due to the desirability of more attention to the beet storage problem and to the recovery of by-products through the use of ion-exchangers. It is a distinct credit to the industry that during the war period just passed, when sugar quality was not a sales factor, high quality was maintained. The excellent cooperation in submitting the composite sugar samples and the operational data was also continued, and this comparative report is made possible only through this cooperation.

PART I

CHEMICAL AND PHYSICAL STUDIES ON THE BEET SUGARS OF THE 1946 CAMPAIGN

By C. A. Fort and S. Byall

A. Factory Operating Data

(1) Quality of beets and diffusion juices. (Table 1) In spite of exceptionally high sucrose contents in the beets in the Eastern area, the general trend in this respect was still downward. Continuation of the cycle of low and high sucrose, which was pointed out in the report for the 1944 campaign, would mean a relatively low sucrose level for another year. The general average reached a high of 16.85 in 1944; in 1945 it was down to 16.10; and this past season it was 15.79. Since data are available for only fifteen years it is uncertain whether the observed cycle was real or accidental but if real, there should be an improved sucrose content in 1948 and a high the following year. Of course, data for limited areas do not follow this general trend, because the average values represent mostly the conditions in areas where factories are most numerous.

The purity of diffusion juice showed another slight decrease. As may be seen on page 5 in Report Number XXIV (issued July 1945), juice purity was lowest in 1935 and increased steadily to a high of 87.3 in 1944. In the past two years it has decreased again, being 86.7 in 1945 and 86.4 in 1946. The non-sugars in juice reached a low of 2.38% on beets in 1942 and have since progressively increased to 2.48%. It is possible that the purity and non-sugars follow the trend in the use of fertilizer rather than being directly correlated with the sucrose content. For example, purities continued to increase during the years 1940-42 in spite of low sucrose.

(2) Liming and Carbonation. (Table 1) These operations averaged as usual except for a small increase in the soda ash used. This increase was possibly due to a larger tonnage of partially deteriorated beets following severe freezing weather in some areas before the beets could be harvested. Continuous first carbonation was put into service at four additional factories. Of the currently operating factories some 20 still use the batch process for first carbonation, but all except five use continuous second carbonation.

(3) Sulphuring. (Table 2) The sulphur used per ton of beets was slightly less than in recent years. Nearly 80% of the factories sulphured thin juice only; the remainder either divided the sulphuring between thin juice and thick juice or used the entire amount on the thick juice. The five factories sulphuring thick juice used only a relatively low amount of sulphur, and the resultant sugars contained 4 p.p.m. SO_2. Six factories of the same area, which sulphured both thin and thick juice, used double the sulphur but still had only the 4 p.p.m. SO_2 in their sugars. Six factories of this area, which sulphured thin juice only, used slightly more sulphur than the last group and the sugars had 8 p.p.m. SO_2. It appears that, for the amount of sulphur used, split sulphuring gave the lowest sulphites in sugars. This result may be due to factors other than the place of sulphuring.

(4) Change in pH During Juice Evaporation. (Table 2) The usual inconsistencies in behavior of the pH during evaporation of juice are evident this year. Since there seems to be a tendency for factories in a given area to show similar trends in pH changes, and also because it has been observed at individual factories that beets from different receiving stations produce a diverse behavior in respect to pH changes, it is evident that some element of non-sugar composition is primarily responsible. All attempts to establish correlations

TABLE 1

BEET END PROCESS DATA

(a) Non-Steffen Operations

Key No.	Beet		Juice		Lime Used % Beets	Soda Lbs.Per Ton	Carbonation		
	Polarization	Purity	Brix	Purity			*Alkalinity 1st	*Alkalinity 2nd	Temp. C° 2nd Carb.
4601	16.72	85.4	12.1	85.8	3.12	0.30	0.087	0.014	85
4603	14.98	--	11.4	86.2	1.49	0.52	0.073	9.2	80
4604	18.85	84.9	12.0	87.4	3.30	0	11.2	9.2	95
4605	15.73	85.9	12.2	88.3	2.03	0.05	0.076	9.2	100
4606A	17.67	80.7	14.7	82.6	3.25	0.40	0.082	0.017	97
4606B	17.35	84.3	14.8	86.2	2.51	0.20	0.082	0.015	97
4608	16.16	86.7	13.5	89.0	1.91	0.27	0.077	8.8	98
4609	17.90	83.0	11.7	87.2	2.20	0	0.082	0.010	97
4610	14.65	--	11.0	86.0	1.42	0.29	0.070	9.2	89
4611	13.81	--	11.2	85.3	1.47	0.48	0.082	9.2	85
4612	15.69	84.1	12.5	86.6	2.01	0	0.069	0.014	96
4613	18.19	89.2	13.3	89.9	2.25	0.02	0.070	8.4	94
4614	14.89	81.7	14.6	85.0	2.57	0.06	0.097	0.017	96
4615	15.89	86.3	13.7	87.1	2.07	0	10.8	9.2	97
4616	16.22	84.9	12.3	86.2	2.33	0.01	0.072	8.9	96
4617	15.77	85.4	14.7	85.6	2.59	0.33	10.5	8.8	98
4618	17.60	86.5	12.8	86.4	2.50	0.15	0.086	9.0	98
4621	16.25	88.7	13.8	87.7	2.23	0.07	0.078	0.021	98
4622	13.36	--	9.8	84.3	1.38	0.10	0.074	9.3	89
4623	18.00	84.3	13.1	87.1	3.22	0.78	0.073	9.1	95
4625	14.60	--	10.5	86.0	1.26	0.20	0.074	9.4	90
4627	17.90	81.0	11.5	86.8	3.41	0.98	0.075	9.0	97
4632	13.89	--	10.2	85.3	1.46	0.23	0.083	9.4	89
4633	17.24	85.8	12.9	86.7	2.81	0	0.068	0.018	80
4634	16.07	84.2	13.8	85.7	2.36	1.37	0.066	9.1	89
4635	15.13	85.6	11.6	86.3	1.94	0.42	0.074	9.3	90
4639	14.47	84.9	11.8	88.7	1.76	0	0.083	9.2	85
4643	16.83	--	11.9	87.9	1.46	0.14	0.071	9.4	--
4645	15.17	83.0	11.7	84.8	2.56	0.61	0.090	0.016	92
4647	17.90	85.0	12.7	86.1	2.60	0	0.075	0.012	100
4649	16.07	--	12.9	88.0	2.26	0	10.9	9.5	98
4650	15.26	--	11.1	86.8	1.74	0.22	0.074	9.2	92
4651	17.65	85.7	13.9	87.4	2.49	0	0.079	8.8	--
4652	17.38	84.4	12.3	87.4	2.50	0	11.1	9.2	93
4654	15.67	84.2	11.2	86.9	2.16	0.31	0.065	9.4	91
4655	17.77	--	13.3	86.3	3.35	1.80	0.058	0.017	85
4659	16.00	86.7	11.8	88.2	2.50	0	0.082	8.8	92
4661	15.74	84.8	13.4	87.2	1.99	0.25	0.071	9.2	90
4662	17.35	87.4	11.1	88.4	3.10	0.37	0.079	0.018	91
4663	17.45	82.5	10.9	87 2	3.79	1.16	0.073	9.4	97
4666	18.85	89.7	12.7	89.5	2.23	0.03	0.065	0.013	98

TABLE 1 - Continued

Key No.	Beet Polarization	Beet Purity	Juice Brix	Juice Purity	Lime Used % Beets	Soda Lbs. Per Ton	Carbonation *Alkalinity 1st	Carbonation *Alkalinity 2nd	Carbonation Temp. C° 2nd Carb.
4669	15.28	84.3	12.7	84.2	2.16	0.10	0.084	9.2	90
4673	14.14	84.8	11.2	85.7	1.97	0	0.077	9.4	90
4676	15.44	86.1	11.8	87.8	3.70	0.41	11.1	9.2	102
4679	15.32	83.5	12.0	85.6	2.60	0.63	0.065	9.4	--
4680	13.84	82.6	12.8	84.1	1.68	0	0.076	0.020	100
4682	14.12	--	10.6	86.2	1.39	0	0.080	9.3	93
4691	18.00	--	13.2	89.8	2.55	0	0.086	0.015	84
4694	16.90	84.1	12.9	88.6	2.68	0	0.075	8.8	92
(b) Steffen Operations									
4602	17.88	--	12.6	86.2	4.51	1.40	0.071	9.0	89
4607	16.13	--	10.8	88.4	2.51	0.20	0.070	9.3	96
4620	15.43	86.4	12.2	86.9	3.39	0.11	0.083	9.3	90
4624	14.94	--	10.0	86.3	3.51	0.30	0.075	9.3	84
4626	13.53	--	10.4	85.1	3.23	0.89	10.6	9.2	83
4628	13.82	79.7	12.4	81.8	6.30	0.50	0.050	8.1	85
4629	14.68	83.3	12.2	86.0	4.26	0.30	0.073	0.011	92
4630	13.91	--	10.6	84.5	2.57	1.18	10.8	9.1	85
4631	14.31	85.3	12.9	85.4	3.64	0.58	10.8	9.1	91
4637	15.75	86.5	12.5	87.9	4.08	0.52	0.069	0.016	92
4640	14.94	85.0	11.2	86.6	3.49	1.31	0.064	0.018	96
4641	14.62	--	10.3	86.0	2.94	0.21	0.073	9.1	85
4642	14.27	--	10.0	86.3	3.31	0.27	0.080	9.2	87
4646	16.22	86.4	12.3	88.0	3.09	0.07	10.7	8.9	90
4653	16.21	86.1	15.0	87.1	3.58	0.76	0.059	8.6	95
4656	13.94	--	10.5	84.9	2.39	0.77	11.0	9.3	86
4657	16.42	86.1	13.8	86.3	3.96	2.26	0.073	0.016	94
4660	13.79	85.7	11.0	87.4	4.27	0	11.1	9.3	99
4664	16.51	81.9	14.5	82.6	4.10	1.11	0.076	8.9	88
4665	15.16	--	11.5	85.5	3.11	0.54	0.069	9.1	83
4668	15.97	85.9	12.0	87.6	4.56	0	0.082	9.6	86
4671	17.13	87.4	12.9	89.4	3.77	0.64	0.066	0.023	96
4672	14.42	--	9.3	85.3	2.88	0.65	0.060	9.2	84
4675	13.49	82.2	10.4	82.6	3.09	0	0.077	9.4	99
4677	15.17	85.1	12.0	85.4	3.81	0.10	0.077	9.2	88
4678	14.48	81.8	12.0	82.4	4.41	1.42	0.078	0.014	86
4683	16.18	83.4	12.3	86.2	4.09	0.01	0.083	0.015	92
4684	16.38	87.1	14.5	88.4	3.15	0.02	0.084	9.9	91
4695	13.34	86.0	12.3	88.5	3.00	0.19	0.076	8.7	86
Avg.(a)	16.136	--	12.3	86.67	2.32	0.28	10.9 pH Alk. 0.076	9.2 pH 0.017 Alk.	93
Avg.(b)	15.203	--	11.9	85.95	3.68	0.58	10.9 pH Alk. 0.073	9.1 pH 0.016 Alk.	90

*Alkalinities given in pH when these data were supplied, otherwise, the value given is the usual titration alkalinity expressed as CaO.

based on any of the constituents normally determined have failed. This is not entirely surprising since few data are available on the non-sugar composition of thin juices and the resulting thick juices, except as they might be deduced from sugar analyses.

(5) Standard Liquor. (Table 2) There was a slight increase in the average density of the standard liquor as filtered. About 70% of the factories filtered at 65° Brix or higher. Nearly half of the factories used either top discharge presses or double filtration or both. Whatever the equipment used the care in maintenance of the presses and in the recirculation are of primary importance in yielding liquors and sugars of low turbidity and low bacterial count.

The use of filter aid shows a decrease as compared with last year, especially at Steffen factories. The annual figures show a fairly steady increase in the use of filter aid for non-Steffen operations but no trend is evident at Steffen factories. The summary for the past seven years follows, and the turbidity values on the corresponding sugars are also given.

Annual Use of Filter Aid

	Non-Steffen		Steffen	
Year	Filter Aid Lbs. Per Ton Beets	Sugar Turbidity Units	Filter Aid Lbs. Per Ton Beets	Sugar Turbidity Units
1940	0.44	--	0.58	--
1941	0.44	4.7	0.57	4.3
1942	0.49	4.2	0.63	5.2
1943	0.56	3.1	0.66	3.3
1944	0.62	3.7	0.57	3.0
1945	0.62	3.3	0.76	3.0
1946	0.60	3.4	0.65	2.3

TABLE 2

INTERMEDIATE PROCESS DATA

(a) Non-Steffen Operations

Key No.	Total Sulphur Used Lbs. Per Ton	Thin Juice pH	Thick Juice		Standard Liquor or Blow-up				
			pH	Purity	Purity	Filtration Brix	Filtration Filter Aid Lbs. Per Ton	Filtration Temp. C°	Lime Salts %
4601	*0.22	8.4	8.6	91.3	92.5	64.1	0.74	93	0.086
4603	0.50	8.1	8.9	--	91.1	67.1	0.42	89	0.045
4604	*0.21	9.2	9.7	91.6	92.4	60.1	0.70	91	0.037
4605	0.47	8.3	9.6	90.7	92.4	67.7	0.61	95	0.033
4606A	0.26	--	8.0	86.8	90.8	63.5	0.69	92	0.156
4606B	0.20	--	8.4	90.3	92.2	62.6	0.43	92	0.054
4608	0.26	8.1	9.3	91.4	92.0	68.3	0.62	92	0.053
4609	0	8.5	9.6	90.5	91.6	65.6	0.45	92	0.042
4610	0.48	8.2	8.9	--	90.8	68.5	0.34	88	0.024
4611	0.59	8.4	9.0	--	90.8	66.4	0.25	91	0.027
4612	0.60	7.4	7.1	85.3	90.0	67.2	0.75	93	--
4613	*0.30	8.6	8.7	92.7	93.2	63.3	0.46	98	0.082
4614	0.30	8.4	9.3	88.6	91.5	66.0	0.63	95	0.043
4615	0.69	8.3	7.6	91.3	93.1	64.2	0.61	93	0.057
4616	0.22	8.3	9.4	90.9	92.2	70.3	0.45	92	0.067
4617	0.43	8.5	7.7	90.9	92.9	65.5	0.55	93	--
4618	*0.30	8.8	8.0	91.8	92.7	59.1	0.39	90	0.057
4621	0.40	7.9	8.0	91.7	93.4	60.2	0.50	94	0.030
4622	0.50	7.9	9.0	--	89.8	66.6	0.40	94	--
4623	*0.13	9.1	9.2	91.3	92.1	65.0	0.62	94	0.034
4625	*0.64	7.9	8.6	--	90.2	70.7	0.48	93	0.034
4627	*0.12	9.0	9.6	91.0	92.6	64.3	0.79	97	0.012
4632	0.56	7.4	8.8	--	90.5	68.6	0.63	93	0.019
4633	0.51	7.9	7.7	--	91.3	60.8	0.14	95	0.104
4634	0.63	8.0	8.8	87.8	92.5	65.0	0.91	94	0.067
4635	*0.61	8.1	9.2	89.7	92.5	65.6	0.38	93	0.055
4638	0.42	8.4	8.8	93.1	93.6	66.4	0.63	96	0.078
4643	0.51	8.2	9.1	--	92.6	68.0	0.34	89	--
4645	0.33	7.8	8.3	90.2	92.7	63.7	0.21	91	0.064
4647	0.30	7.8	8.3	92.3	93.2	62.2	0.87	95	0.058
4649	0.80	7.5	7.7	91.2	92.5	66.6	0.73	97	0.025
4650	0.55	8.0	9.3	--	91.8	67.6	0.73	90	0.039
4651	0.40	8.7	8.4	--	92.1	68.5	0.25	96	0.142
4652	*0.10	9.2	9.5	91.8	91.5	58.5	0.78	90	0.043
4654	0.52	8.1	7.8	91.9	93.1	64.5	0.70	-	--
4655	0.37	8.1	8.3	91.9	92.5	67.8	1.84	90	0.106
4658	0.74	7.8	8.7	92.0	92.1	68.8	0.48	--	0.023
4661	0.65	7.5	7.7	88.8	91.0	67.1	0.77	91	--
4662	*0.45	8.9	8.9	92.7	93.0	58.2	1.13	93	0.065
4663	*0.20	9.4	9.7	91.0	91.4	62.5	0.93	97	0.020
4666	*0.36	8.0	9.2	92.3	92.8	67.2	0.30	90	0.031

TABLE 2 - Continued

Key No.	Total Sulphur Used Lbs. Per Ton	Thin Juice pH	Thick Juice pH	Thick Juice Purity	Standard Liquor or Blow-up Purity	Filtration Brix	Filtration Filter Aid Lbs. Per Ton	Filtration Temp C°	Lime Salts %
4669	0.55	7.9	8.2	90.2	90.5	70.0	0.36	97	0.027
4673	0.27	8.9	9.4	90.0	91.6	59.4	0.39	92	0.127
4676	0.35	8.7	8.4	91.4	93.0	65.4	0.56	93	0.075
4679	0.67	7.5	7.4	89.9	91.3	58.4	1.38	91	--
4680	0.28	8.1	8.3	88.3	90.7	69.5	0.43	94	0.040
4682	0.50	8.3	9.0	89.1	90.5	70.7	0.31	91	0.027
4691	0.34	8.5	9.2	93.6	93.8	64.4	0.83	89	0.029
4694	*0.30	7.9	9.1	92.1	92.7	68.3	0.35	96	0.036
(b) Steffen Operations									
6402	0.17	8.3	8.6	--	93.7	70.6	0.69	97	0.064
4607	0.43	8.0	9.1	--	92.1	70.9	0.46	93	0.018
4620	*0.35	8.6	8.6	89.1	91.2	71.8	0.39	87	0.083
4624	0.50	8.4	8.6	--	91.9	65.5	0.72	97	0.030
4626	0.47	8.7	8.1	--	90.1	68.1	0.93	97	0.033
4628	0.50	7.8	8.9	85.2	89.5	61.7	0.15	90	0.144
4629	0.29	8.2	8.9	90.5	91.9	64.9	0.45	92	0.049
4630	0.62	7.9	8.4	90.7	91.1	69.1	1.43	77	--
4631	0.54	8.0	7.6	90.8	92.3	65.1	0.53	--	0.083
4637	0.25	8.1	8.1	91.1	91.6	65.7	0.49	89	0.124
4640	0.74	7.4	7.5	90.4	90.9	66.0	1.16	82	0.039
4641	0.37	8.1	8.6	--	92.0	69.0	0.49	96	0.043
4642	0.42	7.9	8.6	--	91.8	69.5	0.75	99	0.039
4646	*0.50	7.5	7.0	91.8	93.0	69.0	0.63	96	0.048
4653	0.32	7.4	7.1	92.4	94.3	66.7	0.95	86	--
4656	0.51	8.2	8.7	--	90.5	68.1	0.81	92	0.045
4657	0.70	8.1	7.3	89.0	91.9	65.6	0.38	92	--
4660	0.46	7.9	8.2	91.9	94.4	68.1	0.51	92	0.044
4664	0.19	8.5	7.9	86.8	94.3	68.5	0.31	98	0.077
4665	0.48	8.1	8.9	--	91.0	68.1	0.68	90	0.032
4668	*0.34	8.8	8.1	--	91.1	63.1	0.81	91	0.095
4671	0.12	8.1	8.0	92.5	94.1	69.2	0.45	94	--
4672	0.56	8.1	8.4	--	90.2	68.5	1.18	91	--
4675	*0.68	8.8	9.0	91.0	91.9	64.3	0.54	86	0.050
4677	0.35	8.2	8.4	90.3	91.8	65.3	0.42	94	0.037
4678	0.26	8.6	8.4	87.0	91.1	63.7	0.82	96	0.069
4683	0.18	8.5	7.7	89.1	92.1	62.2	0.42	91	--
4684	*0.47	8.3	9.4	91.0	92.8	64.1	0.32	102	0.035
4685	*0.35	7.8	7.7	91.0	90.8	64.3	0.39	85	0.090
Avg.(a)	0.41	8.3	8.7	90.7	91.9	65.5	0.60	93	0.055
Avg.(b)	0.44	8.2	8.3	90.2	91.9	66.9	0.65	92	0.058

*Factories starred sulphured thick juice with a portion or all of the sulphur used.

The average lime salts remained at a fairly high level in spite of the increased use of soda ash. This tendency to high lime salts has continued for the past five years but was highest in 1944. The general requirement for soda ash is greater at Steffen factories and when processing deteriorated beets. It is probably associated with the quantities of reducing sugars destroyed by the lime. A reasonable approximation of the total lime salt characteristic of different seasons can be obtained by treating as whole numbers the average figure for lime salts of first liquor and that for soda ash used and adding them together. This is true because 0.1 lb. of soda ash per ton of beets is approximately equivalent to 0.01% lime salts on liquor. As an example, the data of the past seven years are summarized in the following table:

Annual Variation in Lime Salts and Soda Ash Used

Year	Non-Steffen Operation			Steffen Operation		
	Lime Salts In Stand. Liquor %	Soda Ash Used Lbs. Per Ton Beets	*Lime Rating	Lime Salts In Stand. Liquor %	Soda Ash Used Lbs. Per Ton Beets	*Lime Rating
1940	0.032	0.14	46	0.055	0.66	121
1941	0.034	0.09	43	0.053	0.57	110
1942	0.033	0.11	44	0.060	0.49	117
1943	0.041	0.14	55	0.049	0.55	104
1944	0.040	0.17	57	0.053	0.46	99
1945	0.042	0.22	64	0.064	0.56	120
1946	0.055	0.28	83	0.058	0.58	116

*Lime rating is sum of figure for lime salts and that for soda ash used, both being considered as whole numbers.

It is seen that for non-Steffen operation the total soda ash requirement has increased more than the soda ash used with a resulting increase in residual lime salts. Steffen operations fluctuate in this respect and show no regular trend.

(3) White Massecuites. (Table 3) The 1946 average white massecuite purities

TABLE 3

SUGAR END PROCESSING DATA

(a) Non-Steffen Operations

Key No.	White Massecuite				White Sugar Washing				Sugar as Sacked	
						Water Used				
	pH	Purity	Brix	Cu. Ft. Per 100 Sugar	Temp. C°	Qts.Per Machine	Qts.Per 100 Sug.	High Wash Purity	Temp. C°	Moisture %
4601	8.1	93.0	91.5	3.40	92	14.0	3.5	92.0	43	0.022
4603	8.8	91.2	90.1	--	91	16.0	3.3	91.4	35	0.023
4604	8.6	92.4	92.2	2.59	105	7.2	2.2	91.4	52	0.027
4605	9.4	92.3	90.8	3.20	108	14.0	4.7	92.9	49	0.035
4606A	7.7	91.4	92.2	2.73	130	13.0	3.9	90.0	--	0.029
4606B	8.2	92.2	92.2	2.73	130	12.0	3.6	90.7	--	0.022
4608	9.5	92.0	91.4	3.36	91	17.0	6.3	88.9	54	0.048
4609	9.6	92.4	90.6	3.04	92	16.0	--	89.7	41	0.038
4610	8.3	91.0	91.2	3.33	95	13.0	7.6	90.8	32	0.010
4611	8.9	90.7	91.8	2.30	96	17.0	6.5	91.6	45	0.021
4612	7.0	88.0	90.0	--	88	--	--	88.0	76	0.033
4613	7.8	93.1	92.0	3.18	98	14.0	3.0	92.8	54	0.028
4614	9.0	91.7	91.9	--	102	16.0	7.0	90.3	45	0.031
4615	7.6	92.8	91.9	2.68	111	18.0	4.7	94.1	46	0.034
4616	9.4	92.2	91.6	3.31	107	14.0	3.4	90.1	50	0.050
4617	7.7	93.1	91.5	3.13	94	16.0	4.6	93.4	46	0.031
4618	8.4	92.8	92.0	2.63	123	--	3.0	92.7	45	0.012
4621	8.0	93.4	90.8	2.82	99	16.0	4.1	--	45	0.022
4622	9.0	89.9	91.4	2.98	97	16.0	5.6	91.1	42	0.020
4623	8.9	92.1	92.2	2.58	105	7.2	3.0	90.0	45	0.030
4625	8.6	90.8	91.9	2.85	95	18.0	7.5	89.5	42	0.017
4627	9.4	92.6	90.8	2.55	99	15.0	5.0	89.7	30	0.028
4632	8.8	90.6	92.2	3.21	92	16.0	--	92.3	33	0.016
4633	7.4	88.1	91.4	3.22	95	20.0	--	88.4	55	0.030
4634	8.6	92.8	91.4	2.90	97	16.0	5.8	94.4	45	0.029
4635	8.5	92.4	91.8	3.22	92	14.0	4.6	93.1	58	0.027
4639	8.6	93.6	92.9	3.30	99	15.0	3.7	93.2	49	0.031
4643	9.1	92.5	90.8	3.29	92	17.0	5.3	91.2	43	0.029
4645	8.2	92.7	92.1	2.73	95	14.5	6.0	90.9	46	0.027
4647	8.3	93.0	91.0	2.29	103	12.0	3.0	91.0	38	0.025
4649	7.6	92.8	90.7	2.86	92	18.0	3.0	91.4	59	0.028
4650	9.1	92.0	90.8	3.35	88	17.0	6.3	92.0	39	0.027
4651	7.7	92.0	89.6	3.31	100	18.0	--	92.2	46	0.033
4652	8.7	90.8	91.4	--	90	17.0	6.5	89.7	44	0.024
4654	7.8	93.1	91.7	--	96	12.0	2.5	--	49	0.029
4655	8.2	91.5	90.1	2.99	90	14.0	--	91.5	--	0.039
4659	8.7	91.8	90.8	3.00	94	12.6	4.3	92.2	47	0.046
4661	7.8	90.8	92.5	2.40	95	12.6	4.2	89.2	63	0.035
4662	8.4	92.7	91.9	3.10	99	15.0	--	90.0	46	0.034
4663	9.1	91.4	92.8	2.77	98	12.9	4.3	89.3	53	0.048
4666	8.1	93.2	91.4	2.88	120	15.5	4.0	92.3	45	0.021

TABLE 3 - Continued

Key No.	White Massecuite				White Sugar Washing				Sugar as Sacked	
						Water Used				
	pH	Purity	Brix	Cu. Ft. Per 100 Sugar	Temp. C°	Qts. Per Machine	Qts. Per 100 Sug.	High Wash Purity	Temp. C°	Moisture %
4600	8.5	91.6	90.7	3.30	92	16.0	5.2	89.7	57	0.036
4673	8.9	91.8	91.4	2.71	96	17.0	6.0	93.1	39	0.034
4676	8.3	93.4	92.3	3.10	111	15.0	5.0	94.9	51	0.023
4679	7.4	91.3	91.0	3.23	92	15.1	3.0	91.3	44	0.042
4680	8.6	90.6	92.6	3.17	117	17.0	6.5	90.7	43	0.047
4682	8.9	90.5	91.1	2.96	92	18.0	7.7	89.4	33	0.024
4691	8.1	86.9	92.3	2.74	90	11.0	4.1	90.7	55	0.025
4694	9.1	92.7	91.8	3.20	125	15.1	5.6	93.7	34	0.031
(b) Steffen Operations										
4602	8.2	93.0	92.2	3.00	99	14.0	6.0	93.4	42	0.027
4607	8.0	92.1	90.8	3.27	97	18.0	5.7	90.1	42	0.033
4620	8.3	91.3	91.5	3.35	94	16.0	7.1	89.8	50	0.028
4624	8.5	92.0	92.2	3.05	91	18.0	6.1	91.2	31	0.021
4626	8.7	90.2	91.2	--	93	20.0	10.0	89.5	33	0.024
4628	8.3	89.7	91.6	--	91	18.0	6.5	89.2	52	0.072
4629	8.8	92.0	91.5	2.77	113	15.0	5.0	92.7	36	0.030
4630	8.5	91.2	89.8	3.51	88	16.0	5.1	90.5	40	0.043
4631	7.8	92.9	89.6	3.20	109	16.3	5.8	94.4	65	0.041
4637	8.3	91.7	91.0	2.74	109	16.0	4.0	91.2	31	0.023
4640	7.5	90.2	92.0	3.61	94	16.0	8.5	88.3	62	0.028
4641	8.0	91.0	91.2	2.90	102	18.0	6.0	90.2	39	0.036
4642	8.7	92.1	91.7	3.27	92	17.0	--	90.8	41	0.024
4646	7.8	92.7	90.1	3.22	98	17.0	--	91.2	48	0.039
4653	7.4	94.3	91.5	--	95	15.9	--	--	51	0.018
4656	8.8	90.7	91.8	3.53	95	14.0	5.8	91.8	37	0.017
4657	7.5	92.1	90.0	3.23	100	16.0	--	--	56	0.037
4660	8.2	94.5	90.4	3.20	113	16.0	--	96.3	42	0.037
4664	7.5	94.5	90.7	--	95	16.0	6.1	93.6	45	0.038
4665	8.9	91.1	89.5	3.01	89	18.0	--	89.7	38	0.044
4668	8.3	91.9	90.7	3.03	91	16.0	6.0	90.0	66	0.042
4671	7.8	94.1	91.2	2.93	95	14.4	4.7	--	45	0.028
4672	8.5	90.3	92.0	3.44	96	16.0	6.9	89.2	40	0.045
4675	8.5	91.0	91.4	3.71	96	16.0	7.5	91.0	48	0.030
4677	8.4	91.6	90.6	2.84	98	16.0	5.7	90.9	49	0.040
4678	8.0	91.3	92.7	2.75	94	16.0	4.5	90.7	45	0.025
4683	7.5	92.1	91.0	2.54	100	18.3	4.2	--	27	0.018
4684	8.3	91.8	91.8	2.70	98	16.0	5.6	90.2	54	0.030
4695	7.3	89.8	89.8	4.11	115	21.4	8.6	87.9	44	0.037
Avg.(a)	8.5	91.8	91.4	3.00	99.6	15.1	4.7	91.2	47	0.030
Avg.(b)	8.2	92.0	91.1	3.12	97.3	16.4	6.0	91.1	45	0.033

are normal. In the past eight years the non-Steffen mean values have ranged from 91.6 to 92.3, so this year's 91.8 purity is on the low side. The mean Steffen massecuite purities have been between 91.8 and 92.4, and this year's 92.0 purity is also slightly below the high figure.

The annual Brix of white massecuites and the cubic feet of massecuite per 100 pounds of recovered sugar are especially uniform. The comparative non-Steffen and Steffen averages for the past six years are as follows:

	Non-Steffen	Steffen
Massecuite purity	92.0	92.1
Massecuite Brix	91.5	91.1
Cu. ft. Massecuite per 100 lbs. sugar	2.93	3.07

(7) Washing of White Sugar. (Table 3) While the amount of wash water remained normal, the temperature of the water averaged higher than previously due to an increase in number of factories using superheated water. It is true that the purity of the high wash is somewhat affected by accuracy in the separation of the wash from the run-off high green sirup, but this wash purity is still a fair gauge of the quality of the washing. The higher the purity of the wash, the better is the quality of the white sugar produced. The efficiency of the washing is dependent on the centrifugal and washing equipment used, as well as the quantity and temperature of the water.

(8) Raw Massecuites and Sugars. (Table 4) The purities of high and low raw massecuites and sugars averaged essentially as usual. On examination of the data of past years, it is to be noted that the purity of the high raw massecuite is nearly constant, therefore, the largest drop in purity in boiling white sugar occurred these years when the white massecuite purity was highest. In non-Steffen operations the mean change in purity between white massecuite and high raw massecuite is 7.3 while for Steffen operations it is only 6.7.

The corresponding values for the change between high raw and low raw masse-cuites are 3.7 and 8.7. It would appear that the rate of crystallization of sucrose from Steffen liquors is much retarded, probably by the nature of the recirculated impurities. These impurities are known to be mostly raffinose, sulphates, and organic salts. Raffinose is somewhat mellassigenic, but sulphates are not. Neither the nature of the organic salts nor their effect on crystallization is well known.

(9) Beet Storage. Of the more than ten million tons of beets sliced this season about 40% were processed after pile storage of over thirty days. In a few instances some of the beets were in storage for more than one hundred days. The problem of protecting such stored beets from excessive respiration, spoilage, and freezing losses is far from solved. Where sunshine is prevalent the use of whitewashing on the exterior of the piles is sure to reduce losses. Also, it appears that the use of supplemental forced ventilation of the piles produces savings in excess of those to be expected from the temperature reduction obtained. Some of the commercial loss is undoubtedly due to breakage of beets during the extra handling and washing and to diffusion of sugar during fluming and washing. These fixed losses make the daily losses for brief periods of storage appear large and far in excess of a reasonable respiration loss. For long storage periods it appears that protection from freezing damage must be developed.

TABLE 4

RAW SUGAR PROCESSING

(a) Non-Steffen Operations

Key No.	High Raw Massecuite			High Raw Sugar Purity	Low Raw Massecuite			Low Raw Sugar Purity	Carbon Used Lbs. Per 100 Sugar
	Purity	Brix	Cu.Ft.Per 100 White Sugar		Purity	Brix	Cu.Ft.Per 100 White Sugar		
4601	85.0	92.5	0.83	98.8	77.7	93.0	0.67	96.8	0
4603	83.0	91.9	--	97.6	73.8	96.0	--	93.7	0
4604	85.0	93.0	0.74	95.2	74.0	93.1	0.49	92.9	0
4605	84.9	92.0	1.90	97.9	75.6	95.7	0.70	89.8	0.02
4606A	86.4	92.3	--	97.9	75.0	94.2	--	93.5	0
4606B	86.7	93.5	--	97.9	75.3	94.2	--	93.9	0
4608	84.2	92.9	1.73	97.5	76.0	93.1	0.57	91.5	0.06
4609	86.1	89.4	1.37	96.8	77.2	91.5	0.54	--	0
4610	82.0	93.6	1.62	--	73.4	97.2	0.68	--	0
4611	83.6	95.6	1.40	98.3	72.7	97.8	0.80	89.3	0
4612	82.7	94.8	1.18	95.9	75.3	94.8	0.57	--	0.08
4613	85.0	93.0	1.09	96.8	77.1	93.7	0.53	94.3	0.004
4614	82.8	94.4	1.61	98.6	72.6	95.3	0.72	92.3	0.002
4615	86.0	93.2	0.97	99.4	76.7	93.1	0.68	94.1	0.054
4616	84.1	93.7	1.72	96.7	72.7	94.2	0.64	89.1	0
4617	87.7	91.9	1.45	99.5	78.3	94.3	0.82	98.2	0.04
4618	84.8	92.4	1.24	97.5	76.1	93.6	1.75	93.5	0.19
4621	87.5	91.7	1.23	99.4	76.7	92.0	0.63	96.2	0
4622	82.7	94.0	2.10	94.9	72.6	97.0	0.84	90.5	0
4623	84.9	92.6	0.77	97.0	77.6	92.9	0.67	94.3	0.07
4625	81.4	93.8	0.95	--	71.6	97.9	0.45	--	0
4627	86.5	91.8	1.02	97.5	78.6	94.1	0.55	93.0	0
4632	85.5	94.1	1.41	97.6	73.5	97.3	0.76	88.0	0
4633	--	--	--	--	74.9	94.2	0.42	94.5	0
4634	88.1	92.3	2.16	98.5	78.3	94.8	0.95	93.7	0
4635	84.9	93.1	2.14	97.9	75.6	95.6	0.84	88.7	0.01
4639	87.4	92.6	1.38	98.2	77.8	93.5	0.60	94.6	0.14
4643	83.9	93.3	1.47	98.1	73.7	95.2	0.47	90.5	0
4645	86.8	92.8	1.69	98.4	78.8	93.1	0.93	96.7	0
4647	86.0	91.2	1.00	98.0	75.0	92.5	0.52	92.0	0.27
4649	86.0	90.5	1.23	96.9	77.1	91.6	0.67	93.1	0.06
4650	83.2	92.1	1.63	97.2	73.6	97.6	0.62	90.5	0
4651	85.2	91.4	1.19	97.1	76.1	93.7	0.66	91.9	0
4652	--	--	--	--	78.0	92.6	0.50	--	0
4654	85.0	91.3	1.05	96.5	77.1	92.6	0.55	91.5	0.16
4655	85.9	91.2	--	97.5	76.9	92.2	--	95.2	0
4659	84.2	92.9	1.19	95.6	74.3	96.9	0.54	87.9	0
4661	82.5	92.6	0.89	95.5	72.9	94.8	0.57	89.5	0.11
4662	84.1	91.8	1.00	97.2	76.1	92.3	0.50	94.5	0.15
4663	82.5	85.2	0.81	97.7	76.9	93.6	0.64	93.6	0.003
4666	84.3	91.7	1.24	96.1	75.8	94.2	0.52	94.7	0.048

TABLE 4 - Continued

Key No.	High Raw Massecuite			High Raw Sugar Purity	Low Raw Massecuite			Low Raw Sugar Purity	Carbon Used Lbs. Per 100 Sugar
	Purity	Brix	Cu.Ft.Per 100 White Sugar		Purity	Brix	Cu.Ft.Per 100 White Sugar		
4669	85.7	90.6	1.64	95.7	76.7	93.9	0.77	92.1	0.04
4673	84.0	94.2	1.43	98.4	75.2	97.0	0.73	92.0	0.094
4676	85.3	92.9	1.96	97.9	74.9	93.2	0.54	90.9	0.13
4679	84.0	91.7	--	97.0	73.7	93.8	--	88.4	0.08
4680	82.5	95.2	2.16	96.6	72.2	96.3	0.88	86.7	0
4682	82.6	93.7	1.20	97.6	71.9	96.9	0.67	88.2	0
4691	86.9	92.3	0.75	96.0	77.3	93.9	0.48	94.0	0.16
4694	85.8	88.9	1.08	97.6	76.3	92.3	0.52	93.6	0
(b) Steffen Operations									
4602	87.2	93.5	2.54	99.0	76.4	94.7	0.88	92.5	0.12
4607	84.8	92.7	1.60	95.3	77.2	94.7	0.60	87.1	0.03
4620	86.4	91.4	1.42	96.1	77.2	92.9	0.75	95.1	0.06
4624	84.7	92.8	1.30	96.4	75.1	95.0	0.66	88.4	0
4626	83.0	92.3	--	91.9	74.9	94.5	0.90	89.0	0
4628	84.8	90.9	--	97.6	78.7	92.4	--	96.4	0.13
4629	84.7	92.9	1.94	97.7	76.2	94.3	0.73	91.7	0.002
4630	85.5	90.9	2.20	96.8	75.7	95.3	0.93	90.6	0
4631	87.0	89.6	1.59	99.5	78.9	90.6	0.99	94.6	0.63
4637	86.2	92.2	1.43	96.8	79.1	93.5	0.87	91.4	0.02
4640	84.2	93.4	1.34	96.9	74.8	93.9	0.72	90.5	0.17
4641	83.6	92.5	1.39	97.3	74.6	94.5	0.65	89.0	0
4642	83.5	91.5	1.76	97.2	76.5	93.0	0.75	90.8	0
4646	86.8	90.8	1.10	98.8	79.0	91.6	0.86	92.6	0.03
4653	88.5	92.1	1.24	99.0	79.3	93.4	0.64	90.4	0.13
4656	82.5	93.1	2.04	96.8	72.8	96.5	0.34	86.6	0.05
4657	86.2	90.7	1.89	99.6	75.8	91.2	0.96	94.3	0.11
4660	88.8	90.8	1.71	99.3	81.0	91.7	0.83	94.1	0.17
4664	86.3	92.5	2.92	99.1	76.1	94.8	1.09	92.5	0.15
4665	84.2	90.7	1.49	96.0	75.3	93.7	0.74	90.2	0
4668	85.8	90.5	1.59	96.3	77.3	91.6	0.71	90.8	0
4671	88.5	91.6	1.38	98.6	80.0	92.7	0.82	96.6	0
4672	82.9	92.8	1.40	94.4	75.3	95.9	0.82	91.7	0
4675	84.7	92.7	1.63	98.2	75.7	95.4	0.86	95.2	0.11
4677	85.4	92.4	1.33	97.1	76.3	93.5	0.72	91.1	0.02
4678	85.9	94.6	1.73	97.8	76.3	95.5	1.09	94.1	0.11
4683	85.7	92.5	1.00	98.3	78.1	92.5	0.82	97.0	0
4684	85.2	90.4	1.06	96.0	76.9	93.5	0.64	92.2	0
4695	82.5	91.7	0.31	96.6	79.3	91.1	0.89	92.9	0
Avg.(a)	84.7	92.5	1.37	97.4	75.3	94.4	0.67	92.3	--
Avg.(b)	85.5	92.0	1.61	97.3	76.8	93.7	0.81	92.0	--

B. Chemical and Physical Data on the Composite Sugars

(1) Ash Content. (Table 5) As for the past few years the figures for ash content are based on specific conductivity. However, a constant factor was not used; instead, the ash values were estimated by the procedure proposed in the report for the 1944 campaign (pages 26-32). This takes into account the conductivity of the inorganic anions of Cl, SO_4 and SO_3 in quantities found to be present.

The non-Steffen sugars were definitely lower in ash as compared with the 1945 sugars, and two-thirds of the factories showed improvement. The Steffen sugars had essentially the same ash content as in the previous year, the carbonate ash being slightly lower and the sulphated ash slightly higher. However, about 60% of these factories produced higher ash sugar than last season. The general average ash level has changed very little in the past ten years.

In the discussion of the washing of white sugar it was mentioned that the efficiency of washing is partly indicated by the purity of the high wash. The evidence of this correlation is seen in the following summarized data:

	Purity of High Wash Below 90°		Purity of High Wash Over 92°	
	Non-Steffen	Steffen	Non-Steffen	Steffen
Avg. Purity of Wash	88.9°	89.1°	93.1°	94.1°
Avg. Sulphates Ash	168 p.p.m.	181 p.p.m.	112 p.p.m.	127 p.p.m.
Avg. Formula Rating, %	92.1	94.2	94.7	97.0
Number of Samples Averaged	8	7	15	5

Note the contrast between 168 p.p.m. of ash associated with a low purity wash and the 112 p.p.m. for sugars with the high purity wash in the case of the non-Steffen sugars and the similar comparison for the Steffen sugars.

(2) Sulphites. (Table 5) While the general mean for SO_2 content is slightly above that for last year this is entirely due to an increase in this

constituent in the Steffen sugars. About 17% of the sugars contained over 10 p.p.m.; only 4% contained over 20 p.p.m.; and 40% contained under 5 p.p.m. Of the thirteen factories which produced sugars containing 10 p.p.m. or more of SO_2, all but three used 0.5 lbs. or more of sulphur per ton of beets. Of the 32 factories whose sugars contained under 5 p.p.m. SO_2, all but four used less than 0.5 lbs. sulphur, and over half of them used less than 0.3 lbs., per ton of beets.

(3) Sulphates. (Table 5) Sulphates (SO_3) in the sugars averaged below last season's figures for both non-Steffen and Steffen factories. Only five sugars contained over 20 p.p.m.

(4) Chlorides. (Table 5) Chlorides (Cl) were higher than normal, the general average being the highest since 1938. It is still a very low amount, and only four sugars had over 20 p.p.m.

(5) Lime. (Table 5) The lime (CaO) content remained at the moderately high level of last year's sugars. Only ten sugars had 10 p.p.m. or higher. The relationship of lime in the sugar to lime salts in standard liquor is very irregular. However, lime in sugars from the ten factories reporting the highest lime salts averages 8.7 p.p.m. while lime in sugars from the ten factories reporting the lowest lime salts averages only 3.4 p.p.m.

(6) Mineral and Organic Salts. (Table 5) The organic salt anion is estimated on the basis described in the 1944 report, pp. 26-32. The sum of the basic equivalents of the determined quantities of SO_2, SO_3, and Cl is subtracted from the total basic equivalent as indicated by the specific conductivity. The organic basic equivalent is calculated to an arbitrary anion having a combining weight of 79. Both mineral and organic salts are calculated as salts of potassium and sodium in the ratio of 2-1.

TABLE 5

MINERAL COMPONENTS OF SUGARS

(a) Non-Steffen Sugars

Key No.	Specific Conductivity X 10-6	Mineral Analyses in p.p.m.				Calculated Ash Content in p.p.m.		Calculated Salts in p.p.m.		
		SO_2	SO_3	Cl	CaO	Carbonate	Sulphated	Mineral	Organic	Total
4601	15.5	2	1	2	5	61	78	11	92	103
4603	25.8	9	9	7	2	98	125	53	94	147
4604	31.8	5	10	16	6	121	155	63	117	180
4605	31.5	4	18	1	5	128	158	48	133	171
4606A	15.0	4	4	2	5	59	75	21	72	93
4606B	14.5	4	7	1	5	55	71	26	61	87
4608	37.6	3	6	9	7	149	191	37	207	244
4609	26.2	3	6	trace	9	108	139	20	162	182
4610	22.5	6	7	10	3	87	111	48	80	128
4611	24.8	7	12	11	6	94	120	62	73	135
4612	65.4	35	22	36	4	241	309	196	128	324
4613	29.2	3	9	trace	7	119	152	26	172	198
4614	30.8	4	7	16	8	119	153	55	126	181
4615	20.0	17	9	6	10	73	93	69	24	93
4616	29.5	5	10	4	8	117	150	40	148	188
4617	15.0	4	3	7	5	57	73	29	56	85
4618	19.8	4	1	2	10	80	102	15	118	133
4621	19.3	14	6	2	5	73	94	48	57	105
4622	27.3	6	14	5	6	105	135	52	109	161
4623	24.7	4	6	1	6	98	126	23	140	163
4625	30.3	11	14	18	5	112	144	89	63	152
4627	28.5	3	8	trace	6	114	146	24	156	180
4632	23.5	8	11	7	1	90	116	55	79	134
4633	15.7	8	4	3	5	60	77	32	57	89
4634	26.8	3	5	10	15	105	134	37	128	165
4635	23.8	9	12	6	4	90	115	57	103	160
4639	no sample									
4643	31.5	7	13	5	1	123	158	52	140	192
4645	20.0	2	3	13	12	76	98	36	79	115
4647	18.2	4	2	1	4	73	93	15	104	119
4649	30.9	22	10	5	1	116	149	81	83	164
4650	19.0	4	3	4	6	76	97	23	99	122
4651	11.8	2	1	2	6	47	60	10	67	77
4652	23.2	6	7	2	9	91	117	32	114	146
4654	26.7	9	8	6	3	103	132	49	109	158
4655	17.1	2	5	trace	9	68	87	16	97	113
4659	34.1	19	15	15	3	126	161	104	66	170
4661	36.7	15	33	18	7	133	170	137	31	168
4662	28.1	4	11	13	4	107	137	57	103	160
4663	22.5	3	4	9	trace	87	112	33	104	137
4666	20.8	6	5	trace	5	83	106	25	109	134

TABLE 5 - Continued

Key No.	Specific Conductivity X 10^{-6}	Mineral Analyses in p.p.m.				Calculated Ash Content in p.p.m.		Calculated Salts in p.p.m.		
		SO_2	SO_3	Cl	CaO	Carbonate	Sulphated	Mineral	Organic	Total
4639	35.1	9	12	5	5	137	175	55	160	215
4673	31.2	3	14	12	15	121	155	59	125	184
4676	13.3	2	4	1	4	52	67	15	71	86
4679	28.5	16	29	13	13	101	130	121	0	121
4680	28.2	5	6	17	6	107	137	57	100	157
4682	28.2	7	4	10	6	109	140	44	125	169
4691	no sample									
4694	22.3	3	3	2	6	89	115	17	134	151
(b) Steffen Sugars										
4602	19.5	3	4	6	10	77	99	27	95	122
4607	30.0	4	8	1	3	120	154	28	172	200
4620	38.2	4	18	15	11	148	190	75	165	240
4624	34.5	11	12	13	6	130	167	75	117	192
4626	31.9	4	18	12	6	121	155	69	111	180
4628	34.5	4	9	15	7	134	172	57	150	207
4629	38.9	4	12	20	8	148	190	73	150	223
4630	35.8	8	13	8	11	139	178	61	155	216
4631	24.8	6	8	1	6	98	126	32	126	158
4637	49.5	5	13	10	8	197	253	58	262	320
4640	44.6	35	11	27	4	161	207	156	46	202
4641	30.0	4	9	10	3	116	149	47	134	181
4642	29.8	5	7	8	3	117	150	41	143	184
4646	25.1	7	5	3	5	99	127	32	127	160
4653	17.8	5	9	1	10	69	88	32	75	107
4656A	23.5	5	6	7	6	91	117	37	105	142
4656B	22.2	4	10	7	3	86	110	43	87	130
4657	24.3	7	9	7	6	92	118	48	90	138
4660	31.5	7	23	13	8	118	151	88	78	166
4664	13.8	3	2	3	4	55	70	17	70	87
4665	32.3	6	10	9	1	126	161	52	144	196
4668	48.0	14	17	4	5	186	239	75	219	294
4671	16.8	2	6	2	8	67	86	21	88	109
4672	34.1	9	13	18	7	126	161	82	102	184
4675	51.9	9	37	20	7	196	251	135	147	282
4677	45.0	11	11	18	4	173	222	83	180	263
4678	23.8	3	4	14	4	92	118	42	96	138
4683	16.1	3	3	2	2	63	81	17	86	103
4684	34.9	10	11	12	9	133	171	69	132	201
4695	42.5	7	9	1	22	172	221	37	251	288
Avg.(a)	25.65	7.2	8.9	7.3	6.0	96.8	126.6	49.1	100.9	150
Avg.(b)	31.14	7.0	11.0	9.9	6.0	119.9	153.8	57.6	125.9	183
*Avg. G	27.77	7.1	9.7	8.3	6.0	107.0	137.1	52.4	110.6	163

*General average

The 1946 non-Steffen sugars were lower than 1945 in both mineral and organic salts, the proportional reduction being nearly 15% in each case. For the Steffen sugars there was an increase in mineral salts which exceeded the very small increase in organic salts. All of the normally Steffen factories which operated non-Steffen process in 1945 continued to do so, and one additional Steffen factory made the shift. This situation affects the comparison of annual averages, since so many of the factories involved are in one geographical area.

(7) Reflectance. (Table 6) The reflectance values for the sugars remained at the high level of the 1945 sugars; in fact, the general average was the highest yet recorded, but the margin of difference was very small. The general average for 1945 was 93.5 as compared with the current value of 93.6.

(8) Color and Turbidity in Solution. (Table 6) The higher average for color in solution was largely the effect of an especially high color in a few samples. Turbidity, on the other hand, remained at a low level. The clarity of sugars in solution has improved steadily through the past twenty years, and very few sugars show more than a trace of turbidity.

(9) Foaming Test. (Table 6) The results of foaming tests agreed closely with last year's low values. There were no high-foaming samples either year. The stirring technique is still used in the testing, so the low values obtained are especially favorable.

(10) Formula Rating Percentages. (Table 6) The overall sugar quality as indicated by the arbitrary formula rating percentage shows little change from last year. There was some decrease in the values for the non-Steffen sugars, partly due to the higher sugar solution color. It may be noted that one sample of sugar met the arbitrary sugar standard completely and several others

PHYSICAL PROPERTIES AND RATING OF SUGARS

(a) Non-Steffen Sugars

Key No.	Reflectance	Sugar Solution			Foaming Test		Formula Rating Percentage	Fineness Moduli
		Color	Turbidity	pH	Maximum	Final		
4601	92.6	11.8	19.9	7.20	105	75	73.2	57.7
4603	93.3	2.4	3.1	7.60	95	80	96.5	52.2
4604	93.6	2.9	2.4	7.52	100	80	95.5	47.9
4605	94.1	3.1	2.3	7.30	100	75	96.0	31.5
4606A	93.3	2.2	2.8	6.90	95	75	97.5	39.8
4606B	93.3	2.6	3.2	7.05	100	80	96.9	38.0
4608	92.3	7.7	3.9	7.85	95	80	88.3	32.4
4609	91.2	6.7	2.8	7.90	95	70	88.8	38.9
4610	92.3	1.7	2.7	7.70	100	85	95.7	57.0
4611	91.8	1.5	2.4	7.85	105	80	94.7	73.0
4612	91.2	2.6	2.1	6.82	95	75	88.3	49.6
4613	90.8	2.2	2.7	7.38	110	85	92.0	44.9
4614	92.8	2.3	2.4	7.89	95	70	96.0	28.0
4615	93.6	2.9	3.0	7.00	105	80	94.0	45.0
4616	92.5	2.3	2.8	7.45	100	75	94.8	47.8
4617	91.8	2.1	3.4	7.30	110	80	93.7	40.2
4618	94.8	2.3	2.2	7.00	90	75	100.0	53.2
4621	94.8	2.6	2.4	7.00	105	80	96.5	28.2
4622	94.8	1.6	2.1	7.23	105	75	98.4	48.0
4623	93.2	1.5	1.6	7.48	100	70	97.8	78.0
4625	94.0	1.3	2.1	7.32	110	75	96.5	34.9
4627	93.6	4.1	4.8	7.78	100	85	93.0	47.2
4632	94.6	1.7	3.0	7.20	110	85	96.8	39.3
4633	93.3	1.5	2.8	6.91	105	90	96.7	56.3
4634	92.6	4.5	2.1	7.05	105	85	92.6	68.1
4635	93.2	2.6	2.7	7.03	110	90	94.1	38.2
4639	no sample							
4643	94.4	1.8	3.1	7.05	115	80	95.4	41.6
4645	92.4	2.0	2.8	7.42	95	80	96.7	43.6
4647	94.0	1.6	2.3	7.01	110	80	97.4	30.8
4649	94.1	1.5	3.6	6.70	100	80	95.2	40.0
4650	93.8	1.5	3.2	6.98	100	80	97.9	60.7
4651	94.6	2.3	2.1	6.88	105	80	98.6	30.5
4652	93.2	3.6	7.0	6.91	105	80	91.1	76.0
4654	94.7	1.9	6.7	6.78	95	70	96.0	40.4
4655	93.8	1.9	3.2	7.08	95	80	98.4	38.8
4659	94.6	2.8	2.3	7.00	110	85	94.1	37.0
4661	94.5	2.4	3.0	6.90	105	80	91.2	58.1
4662	93.8	1.4	2.6	7.18	115	80	96.0	53.0
4663	92.9	2.4	2.2	7.40	100	75	96.3	69.9
4666	94.2	1.4	2.2	7.20	95	80	99.4	42.0
4669	93.0	1.6	2.3	7.03	100	75	95.8	35.1
4673	94.2	1.3	3.4	7.25	95	75	98.5	24.8
4676	94.6	2.6	3.0	7.41	90	75	99.5	43.0

Key No.	Reflectance	Sugar Solution			Foaming Test		Formula Rating Percentage	Fineness Moduli
		Color	Turbidity	pH	Maximum	Final		
4679	94.1	2.1	3.1	6.80	90	75	97.0	28.0
4680	92.8	3.3	2.4	6.83	95	80	94.9	36.0
4682	94.2	2.6	1.6	7.10	105	80	96.5	27.9
4691	no sample							
4694	94.6	3.0	2.2	7.32	95	80	98.1	35.6
(b) Steffen Sugars								
4602	94.7	4.6	4.5	7.85	100	85	95.8	40.3
4607	93.9	2.8	3.4	7.65	100	80	95.7	33.8
4620	91.8	2.3	2.5	7.20	90	80	95.1	30.1
4624	94.5	2.8	2.7	7.38	100	75	95.8	37.8
4626	95.1	1.5	2.7	7.42	100	80	99.1	36.2
4628	94.2	4.7	2.9	7.42	110	85	92.6	41.9
4629	94.6	2.6	2.7	7.48	100	80	96.8	29.3
4630	93.8	2.4	2.9	7.50	105	85	93.7	52.7
4631	94.0	2.3	2.8	7.18	100	85	96.8	25.1
4637	94.4	3.3	2.8	6.38	95	85	95.3	41.5
4640	94.2	2.0	3.6	6.50	100	75	92.3	32.3
4641	94.1	2.3	2.3	7.00	100	85	97.2	44.7
4642	94.6	2.6	2.8	7.50	105	85	96.4	23.8
4646	94.1	2.7	2.4	7.01	105	80	95.9	39.9
4653	94.0	3.0	2.8	6.90	100	80	96.5	40.6
4656A	94.3	2.1	1.9	7.20	100	80	98.1	47.1
4656B	91.8	1.5	1.6	7.10	95	75	96.9	63.1
4657	94.0	2.6	3.0	7.00	100	85	96.3	30.7
4660	94.4	1.5	2.1	6.88	105	85	97.7	27.2
4664	94.1	2.6	2.2	7.35	100	75	96.0	43.3
4665	93.4	1.7	2.4	7.28	110	80	95.4	46.6
4668	92.7	1.9	1.9	6.98	105	85	93.3	42.9
4671	92.7	1.6	3.4	7.10	105	80	96.0	43.7
4672	92.7	1.1	1.5	7.03	100	75	96.7	36.3
4675	94.3	1.5	4.6	7.30	110	80	94.6	42.5
4677	94.0	2.6	3.4	7.05	95	85	94.9	42.5
4678	94.0	2.9	3.1	7.13	90	75	97.7	57.1
4683	93.4	3.2	2.7	7.03	100	80	96.0	65.3
4684	94.2	2.3	3.1	7.13	100	80	95.9	26.2
4695	91.7	4.1	2.4	7.00	120	100	88.3	40.2
Avg.(a)	93.45	2.67	3.39	7.25	101.4	78.8	95.0	45.2
Avg.(b)	93.88	2.45	2.78	7.17	100.9	80.9	95.9	40.1
*Avg. G	93.62	2.58	3.15	7.22	101.2	79.6	95.3	42.7

*General average

were very close to the 100% mark. As in past years, the formula rating is based on sulphites, sulphated ash, solution color and turbidity, reflectance, and foaming.

(11) Screening Tests. (Table 7) The screening tests were made on 100-gram portions of sugar taken from one-half of a two-pound lot of sugar put through a Jones Sampler riffle. This is a step in the right direction, but even more thorough mixing would be desirable considering the difference in results of tests made last year on duplicate samples from the same lot of sugar. The data obtained were used in calculating a fineness modulus according to the method of Nees. The average grain size on this basis is somewhat smaller than last year, but a number of samples are relatively coarse. The relation of grain size to reflectance measurements is well known, but there were a number of samples which did not show the usual trend to lower reflectance for the larger grain size. The sixteen sugars with fineness moduli over 50 averaged 93.3 reflectance, while the twenty sugars with fineness of 35 or below averaged 93.9 reflectance. Therefore, the effect of grain size on reflectance would not appear to be very pronounced in this range.

SUMMARY

The operational data for 1946 indicate a lower-sucrose beet and a lower-purity juice were processed; yet the general quality of the white sugar product was well maintained. The few sugars that were out of line in respect to particular tests are obvious in the tables and require no comment. On the basis of the formula rating, over 70% of the sugars were equal to or better than 95% of the standard and only 5% rated lower than 90% of the standard.

TABLE 7

SCREENING TESTS ON SUGARS

(a) Non-Steffen Sugars

Key No.	Percent Retained on U. S. Screens Nos. 20	30	40	50	60	70	80	100	Through No. 100	Total on 40 and 50	Fineness Modulus
4601	0.1	5.3	35.6	30.3	10.9	6.8	3.9	3.5	1.6	65.9	57.7
4603	0.1	2.5	33.0	35.9	11.0	8.4	4.8	3.5	0.8	68.9	52.2
4604	0.1	4.9	28.0	30.4	13.0	11.0	6.1	5.0	1.5	58.4	47.9
4605	0.0	1.0	17.2	36.1	17.0	13.3	6.8	6.0	1.2	53.3	31.5
4606A	0.2	1.0	24.6	34.0	14.5	13.0	5.5	5.0	2.1	58.8	39.6
4606B	0.0	1.4	25.0	30.5	14.3	12.9	7.0	6.0	2.9	55.5	38.0
4608	0.0	1.3	20.1	31.0	13.7	13.0	8.0	7.7	5.2	51.1	32.4
4609	0.5	5.4	28.4	32.0	13.0	10.9	5.0	3.4	0.4	61.4	38.9
4610	0.1	3.0	35.6	36.2	11.0	7.5	3.3	3.0	0.3	71.8	57.0
4611	0.0	5.7	43.9	33.8	9.0	4.3	1.5	1.0	0.3	77.7	73.0
4612	0.0	2.0	31.0	36.5	13.0	9.2	4.5	3.0	0.8	67.5	48.6
4613	0.0	4.0	28.5	28.3	12.5	11.8	6.9	5.2	2.8	56.8	44.9
4614	0.0	1.0	12.7	35.0	18.2	14.8	9.1	8.0	4.2	47.7	28.0
4615	0.2	1.5	27.0	38.0	13.5	9.8	4.4	4.0	1.6	65.0	45.0
4616	0.5	1.2	29.0	38.0	13.2	10.5	4.6	2.4	0.6	67.0	47.8
4617	0.0	0.5	22.0	42.7	15.3	10.7	4.5	3.1	1.2	66.7	40.2
4618	0.0	3.0	33.5	34.5	12.0	8.5	4.5	3.5	0.5	68.0	53.2
4621	0.0	0.5	11.0	38.4	18.0	15.5	6.8	6.0	3.8	49.4	28.2
4622	0.0	3.0	29.3	35.5	11.5	9.0	5.1	5.0	1.6	64.8	48.0
4623	0.2	12.7	39.0	26.0	9.0	7.0	3.5	2.0	0.6	65.0	78.0
4625	0.0	1.0	22.0	33.0	13.2	12.6	7.5	6.5	4.2	55.0	34.9
4627	0.0	2.7	28.5	35.0	13.3	10.7	5.0	4.0	0.8	63.5	47.2
4632	0.0	0.5	22.5	40.5	14.4	10.5	5.0	4.0	2.6	63.0	39.3
4633	0.0	1.7	37.0	37.5	10.0	7.5	3.0	2.5	0.8	74.5	56.3
4634	0.2	7.6	39.3	29.0	10.4	7.5	3.2	2.1	0.7	68.3	68.1
4635	0.0	0.5	22.0	38.2	15.5	12.0	5.6	5.0	1.2	60.2	38.2
4639	no sample										
4643	0.0	2.2	24.0	36.5	13.7	11.0	5.3	5.0	2.3	60.5	41.6
4645	0.0	2.8	30.1	34.0	12.5	11.0	5.0	4.0	0.6	64.1	46.6
4647	0.0	1.5	17.5	29.5	15.8	16.1	8.5	7.0	4.1	47.0	30.8
4649	0.0	1.5	24.0	36.0	13.0	10.5	6.0	5.5	2.6	60.9	40.6
4650	0.0	1.5	37.0	33.0	10.0	7.5	3.8	2.7	0.8	70.9	60.7
4651	0.0	1.2	25.0	17.0	14.8	16.5	10.0	9.5	6.0	42.0	30.5
4652	0.2	11.8	39.5	26.0	8.5	7.0	3.5	2.7	0.8	65.5	76.0
4654	0.0	0.5	21.0	44.2	14.5	11.2	4.3	3.7	0.6	65.2	40.4
4655	0.2	1.8	24.5	30.3	15.5	13.0	6.0	5.3	3.4	54.8	35.8
4659	0.0	1.7	32.5	32.5	14.5	13.0	6.1	7.0	2.7	55.0	37.0
4661	0.0	1.7	35.0	43.0	11.5	6.0	2.0	0.6	0.2	78.0	58.1
4662	0.2	3.0	33.0	35.3	11.1	8.7	4.0	3.2	1.5	68.3	53.0
4663	0.0	6.5	40.7	33.0	10.0	6.0	2.1	1.3	0.4	73.7	69.9
4666	0.0	3.3	20.3	28.5	12.5	13.0	6.7	6.0	3.2	54.3	42.0

TABLE 7 - Continued

Key No.	Percent Retained on U. S. Screens Nos. 20	30	40	50	60	70	80	100	Through No. 100	Total on 40 and 50	Fineness Modulus
4669	0.0	1.0	22.5	32.7	13.8	11.5	6.5	7.0	5.0	55.2	35.1
4673	0.0	1.0	14.5	27.0	14.5	15.0	8.7	10.5	8.8	41.5	24.8
4676	0.0	1.0	26.5	37.8	14.0	10.0	5.0	3.6	2.1	63.3	43.0
4679	0.0	0.2	9.0	41.0	20.0	15.5	6.5	5.4	2.4	50.0	28.0
4680	0.0	2.0	22.5	30.7	13.5	13.0	7.0	7.5	3.8	53.2	36.0
4682	0.0	0.5	16.0	32.0	14.5	13.5	8.0	8.7	6.8	48.0	27.9
4691	no sample										
4694	0.0	1.5	14.0	35.2	16.5	14.8	6.0	5.0	2.0	54.2	35.6
(b) Steffen Sugars											
4602	0.0	0.5	25.2	37.0	13.9	11.3	5.5	4.8	1.8	62.2	40.3
4607	0.0	1.0	19.7	37.0	16.5	11.7	6.0	5.0	3.1	56.7	33.8
4620	0.0	0.2	16.6	36.5	15.3	11.7	5.8	7.0	6.9	53.1	30.1
4624	0.0	1.0	13.7	42.3	16.7	10.5	4.8	3.7	2.3	61.0	37.8
4626	0.0	1.0	20.7	36.5	14.1	12.7	7.0	5.7	2.3	57.2	36.2
4628	0.0	1.5	23.0	30.0	16.0	11.4	5.0	3.5	0.6	62.0	41.0
4629	0.0	1.0	14.7	33.0	18.0	14.5	7.0	6.8	5.0	47.7	29.3
4630	0.2	5.7	31.5	29.0	11.6	9.5	6.0	5.4	1.1	60.5	52.7
4631	0.0	0.5	12.5	30.0	16.7	16.0	9.8	9.2	5.3	42.5	25.1
4637	0.0	1.0	23.5	37.5	14.8	10.0	6.0	5.0	1.3	61.0	41.5
4640	0.0	3.2	12.8	43.6	13.5	13.4	5.8	4.5	1.2	56.4	32.3
4641	0.0	0.9	27.0	40.8	12.8	9.0	4.0	4.0	1.5	67.8	44.7
4642	0.0	0.5	12.5	30.6	14.5	13.0	9.0	11.2	8.7	43.1	23.8
4646	0.0	1.2	24.0	35.5	15.0	12.3	5.5	5.0	1.5	59.5	39.0
4653	0.0	0.2	27.3	36.5	11.5	10.0	5.7	6.0	2.8	63.8	40.6
4656A	0.0	1.7	31.0	36.0	11.0	8.2	4.5	4.8	2.8	67.0	47.1
4656B	0.2	3.2	40.0	37.0	8.8	5.0	2.3	2.2	1.3	77.0	63.1
4657	0.0	0.2	12.0	41.8	18.2	15.3	6.0	4.7	1.8	53.8	30.7
4660	0.0	0.5	14.0	32.5	15.8	14.5	9.0	8.8	4.8	46.5	27.2
4664	0.0	1.3	27.5	35.0	14.0	11.2	5.0	4.5	1.5	62.5	43.3
4665	0.0	2.2	29.0	36.8	12.0	8.2	4.8	4.5	2.5	65.8	46.6
4668	0.0	1.0	24.2	40.5	16.0	9.5	4.3	3.7	0.8	64.7	42.9
4671	0.0	1.2	26.6	37.7	13.5	10.3	5.0	3.9	1.6	64.5	43.7
4672	0.0	0.7	18.0	42.1	16.5	10.5	5.0	4.5	2.7	60.1	36.3
4675	0.0	0.5	20.2	38.3	14.5	10.5	5.0	3.8	1.2	64.5	42.5
4677	0.0	0.5	23.0	44.0	15.5	9.5	3.7	3.0	0.8	67.0	42.5
4678	0.0	3.5	36.0	34.5	10.5	8.2	3.8	2.7	0.8	70.5	57.1
4683	0.2	1.3	41.7	42.0	9.0	4.0	1.3	0.2	0.3	83.7	65.3
4684	0.0	0.2	8.3	40.0	20.0	14.2	6.2	5.5	5.6	48.3	26.2
4695	0.0	2.2	23.3	35.0	14.8	11.0	6.2	5.0	2.5	58.3	40.2
Avg.(a)	0.06	2.72	26.95	33.83	13.19	10.88	5.42	4.71	2.22	60.8	45.2
Avg.(b)	0.02	1.22	23.01	37.34	14.53	10.90	5.48	4.05	2.55	60.4	40.1

CaFort:SByall:LW
6/10/47

PART II

BIOLOGICAL STUDIES OF SUGARS

By H. H. Hall and Dorothea J. Teunisson

The data presented in this part of the report concerns the biological quality of the sugars. The samples were examined for various microorganisms, particularly aerobic and anerobic thermophilic bacteria, mesophilic bacteria, yeasts, and molds which might influence the desirable characteristics or keeping quality of canned foods, beverages, dairy products, frozen foods, desserts, candies, etc. Examination of the samples was likewise made to determine the relative amounts of substances which stimulate the growth of yeast in sugar solutions and which therefore help to determine the suitability of the sugar for use in the manufacture of beverages.

The data were obtained by the examination of samples described in the preceding part of the report, and the same identification numbers have been used. The results are given in two sections, namely: (1) examination for microorganisms, and (2) examination for yeast growth-promoting substances.

EXAMINATION FOR MICROORGANISMS

The examination for microorganisms was limited to the detection and enumeration of the numbers of characteristic organisms of two groups which are considered to be of economic importance in the industrial use of sugar, namely: (1) thermophilic organisms, and (2) mesophilic organisms. These groups are differentiated by the temperature requirements for optimum growth. Whereas the incubation temperature for the culture of thermophilic organisms is 55° C. (131° F.), the latter group is best cultured at 30° C. (86° F.). There are specific types of organisms in each group for which examination was made and for which selected culture media were used.

Thermophilic Bacteria. The samples were examined for spores of all three groups of thermophilic bacteria that are important as spoilage agents in non-acid canned foods, i.e., flat sour bacteria (Bacillus stearothermophilus), sulfide spoilage bacteria (Clostridium nigrificans), and thermophilic anaerobes not producing hydrogen sulfide (Cl. thermosaccharolyticum), frequently referred to as the "hard swell" type. References to various publications regarding the presence and significance of these types of microorganisms occurring in sugar have been given in previous reports. Several of these, repeated for the benefit of those who have recently undertaken bacteriological testing, are as follows: Cameron, E. J. and C. C. Williams, (1938) The Thermophilic Flora of Sugar in its Relation to Canning, Jour. Bact., Vol. 15, page 31; Cameron, E. J. and J. Yesair, (1931) Sugar Contamination; Its Effect in Canning Corn, Canner, Vol. 72; Owen, W. L. and R. Mobley, (1932) Thermophilic Bacteria in Refined Cane Sugars, Indus. and Engin. Chem., Vol. 24, page 104; Calton, C. F. (1936) Thermophilic Contamination Within the Sugar Factory, Indus. and Engin. Chem., Vol. 28, page 1235.

The methods and culture media used for examining the samples for thermophilic bacteria are given in the Official and Tentative Methods of the Association of Official Agricultural Chemists, Sixth Edition, 1945, pages 753-755, with the exception that modified culture media, described below, were used for detecting organisms of the hydrogen sulfide and "hard swell" types. The formula of the medium used for detecting organisms of the hydrogen sulfide type is as follows:

Tryptone (Bacto)	10 grams
Sodium sulfite	1 gram
Ferric citrate (5% sol'n.)	10 mls.
Agar	20 grams
Distilled water	1000 mls.

Tube and autoclave at 15 pounds for 20 minutes.

Inoculation and incubation of tubes of this medium and recording of results are the same as described in the above reference. The formula of the medium used for detecting organisms of the "hard swell" type is as follows:

Tryptone (Bacto)	10 grams
Dextrose	5 grams
Potassium phosphate (dibasic)	1.25 grams
Yeast extract (Bacto)	1 gram
Distilled water	1000 mls.

Tube and autoclave at 15 pounds for 20 minutes.

Stratifying medium

Tryptone	5 grams
Agar	15 grams
Distilled water	1000 mls.

Flask and autoclave at 15 pounds for 20 minutes.

Inoculation and incubation of tubes of this medium and recording of results are the same as described in the above references.

It will be recalled that bacterial standards have been adopted for canning-grade sugars based on the permissible number of thermophilic bacteria spores contained in a given quantity of sample. The standards are given for ready reference as follows:

Total Aerobic Thermophilic Spores shall not exceed 125 per 10 grams of sugar.

Aerobic Flat Sour Spores shall not exceed 50 per 10 grams of sugar.

Anaerobic Sulfide Spoilage Spores shall not exceed 5 per 10 grams of sugar.

Anaerobic Hard Swell Spores shall not be present in more than four (66.6%) of the six tubes of medium inoculated with the test sample.

The results of the examination of samples to determine their quality in relation to the above standards are given in Table I.

Seventy-seven samples were examined and seven, or 9.1%, did not meet the specifications set forth for canning-grade sugar. These seven samples were contaminated with excessive numbers of flat sour spores. Three of them also had higher total aerobic spore counts than permitted by the specifications. None of the samples was found to contain excessive numbers of sulfide or hard swell spores, a condition which was also found last year. On the basis of these results it is apparent that a laboratory conducting examinations of shift or daily composite samples need not place the same emphasis on anerobic types of organisms as is placed on the more numerous aerobic types.

TABLE I

BACTERIOLOGICAL EXAMINATION OF 1946 SUGARS

	THERMOPHILIC BACTERIA				MESOPHILIC ORGANISMS			
	Aerobes		Anaerobes		Aerobic Bacteria		Yeasts	Molds
Sample No.	Total Count Per 10 Gm.	Flat Sour Per 10 Gm.	Sulfide Spores Per 10 Gm.	Hard Swell % Tubes With Growth	Total Per 1.0 Gm.	Acid-Forming Per 1.0 Gm.	Total Per 1.0 Gm.	Number Colonies Per 1.0 Gm.
4601	260	260	0	0	16	8	0	0
4602	15	0	0	0	23	6	0	0
4603	25	5	0	0	13	1	0	2
4604	10	0	0	50	15	3	0	0
4605	0	0	0	0	5	1	0	0
4606A	25	25	0	0	30	10	0	0
4606B	10	5	0	0	25	13	0	0
4607	0	0	0	0	25	13	0	0
4608	0	0	0	0	46	11	0	4
4609	5	5	0	0	78	55	0	0
4610	0	0	0	0	19	3	0	10
4611	10	0	0	0	*	*	0	48
4612	40	30	3	0	64	31	0	3
4613	0	0	0	0	20	12	0	2
4614	0	0	0	0	17	0	0	0
4615	5	0	0	0	5	3	0	0
4616	0	0	3	0	8	3	0	0
4617	0	0	0	0	20	3	0	0
4618	60	55	0	17	18	7	0	4
4620	25	25	0	17	107	74	0	7
4621	0	0	0	0	16	9	0	2
4622	0	0	0	0	57	11	0	3
4623	5	5	0	0	88	64	0	0
4624	0	0	0	0	15	1	0	2
4625	10	5	0	0	14	5	0	0
4626	5	5	0	0	44	5	0	0

TABLE I - Continued

Sample No.	THERMOPHILIC BACTERIA: Aerobes: Total Count Per 10 Gm.	THERMOPHILIC BACTERIA: Aerobes: Flat Sour Per 10 Gm.	THERMOPHILIC BACTERIA: Anaerobes: Sulfide Spores Per 10 Gm.	THERMOPHILIC BACTERIA: Anaerobes: Hard Swell % Tubes With Growth	MESOPHILIC ORGANISMS: Aerobic-Bacteria: Total Per 1.0 Gm.	MESOPHILIC ORGANISMS: Aerobic-Bacteria: Acid-Forming Per 1.0 Gm.	MESOPHILIC ORGANISMS: Yeasts: Total Per 1.0 Gm.	MESOPHILIC ORGANISMS: Molds: Number Colonies Per 1.0 Gm.
4627	45	35	0	0	14	4	0	2
4628	75	65	0	0	260	195	0	32
4629	165	100	0	0	8	3	0	0
4630	20	15	0	0	83	6	0	20
4631	5	0	0	0	224	167	1	1
4632	20	20	0	0	40	6	0	1
4633	30	25	0	0	25	11	2	4
4634	15	15	0	0	70	42	0	0
4635	5	5	0	0	2	0	0	0
4637	185	85	0	0	62	35	0	0
4640	0	0	0	0	13	6	0	0
4641	0	0	0	0	27	6	0	1
4642	5	5	0	0	16	3	0	2
4643	5	0	3	0	14	8	0	20
4645	5	0	0	0	12	3	0	0
4646	0	0	0	17	4	0	0	0
4647	20	15	3	50	77	40	0	3
4649	20	15	0	0	22	13	0	1
4650	20	20	0	0	13	1	0	5
4651	65	50	0	0	93	69	0	1
4652	10	0	0	17	4	1	0	6
4653	0	0	0	0	15	0	0	1
4654	5	0	0	0	30	25	0	311
4655	125	105	0	17	24	11	0	4
4656A	10	10	0	0	42	5	0	0
4656B	20	15	0	0	11	1	0	1
4657	25	20	0	33	37	16	0	1
4659	0	0	3	0	9	3	0	0
4660	35	15	0	0	18	12	0	5

TABLE I - Continued

Sample No.	THERMOPHILIC BACTERIA: Aerobes: Total Count Per 10 Gm.	THERMOPHILIC BACTERIA: Aerobes: Flat Sour Per 10 Gm.	THERMOPHILIC BACTERIA: Anaerobes: Sulfide Spores Per 10 Gm.	THERMOPHILIC BACTERIA: Anaerobes: Hard Swell % Tubes With Growth	MESOPHILIC ORGANISMS: Aerobic-Bacteria: Total Per 1.0 Gm.	MESOPHILIC ORGANISMS: Aerobic-Bacteria: Acid-Forming Per 1.0 Gm.	MESOPHILIC ORGANISMS: Yeasts: Total Per 1.0 Gm.	MESOPHILIC ORGANISMS: Molds: Number Colonies Per 1.0 Gm.
4661	10	10	0	0	10	3	0	1
4662	55	35	0	0	18	11	0	0
4663	5	0	0	0	26	11	0	187
4664	0	0	0	0	33	28	0	6
4665	20	15	0	17	60	60	0	10
4666	75	40	0	0	19	11	0	2
4668	5	5	0	0	47	14	0	6
4669	10	5	0	0	24	4	0	25
4671	20	0	0	0	22	10	0	1
4672	10	5	0	0	360	90	0	0
4673	10	5	0	0	45	3	0	7
4675	70	40	0	0	58	52	0	0
4676	0	0	0	0	13	6	0	4
4677	30	15	0	17	92	7	0	2
4678	10	10	0	0	25	17	0	0
4679	25	15	0	0	16	12	0	5
4680	0	0	0	0	6	2	0	0
4682	20	20	3	17	11	4	0	4
4683	5	5	0	0	7	1	0	1
4684	20	15	0	0	49	26	0	0
4694	10	0	0	0	77	10	0	2
4695	105	90	5	17	18	4	0	1

*Plates overgrown with molds.

A comparison of the factories whose samples were excessively contaminated this year with those of the previous year shows that three factories had excessively contaminated samples for both campaigns. A further comparison of all factories submitting excessively contaminated sugar during the past four campaigns is made in Table II and shows that during these years one factory, No. --28, did not manufacture sugar that met the canning-grade specifications. Among the factories represented by samples listed in Table II, seven had two or more composite samples with excessive numbers of thermophilic spores during the past four campaigns:

TABLE II

SAMPLES EXCESSIVELY CONTAMINATED WITH THERMOPHILIC SPORES DURING PAST CAMPAIGNS

1946	1945	1944	1943
4601	N. S.	4401	
		4406	
			4311
		4413	
4618	N. S.		N. S.
	4523	4423	N. S.
4628	4528	4428	4328
4629	4529		
4637			
N. S.		4439	
	4547		
4655		4455	N. S.
	4562	N. S.	N. S.
	4575	4475	4375
	4577		
4695	4595		

N. S. = No Sample

The examination of composite samples of sugar for thermophilic organisms was begun on the 1933 campaign samples. At that time there were literature reports indicating that thermophilic organisms were present in varying numbers and that sugar had been found to be the source of food spoilage organisms. As a result all of the samples available that year were examined by methods recommended by the National Canners' Association laboratory to determine their quality in respect to standards which had already been suggested for canning-grade sugar. Of the 58 samples examined 39, or 67.2%, were found acceptable for canning purposes. The same tests were made each year thereafter with the same techniques and media, or suitable modifications thereof, on the composite samples. The number of samples examined each year, except 1934, together with the number and per cent of samples meeting the specifications, is given in Table III. The results for 1934 are omitted because it is believed they did not represent the true quality of the sugar. From the table it is seen that the quality of the sugar improved steadily from 1933 through 1938, a period when field studies were being made to determine the sources of the organisms in the sugar and of methods for their elimination. It will be noted that at no time did all samples meet the canning-grade specifications. The failure of some samples to meet the specifications does not mean that all strikes of sugar comprising the composite sample were excessively contaminated; this was demonstrated by the examination of strike samples from individual factories.

Mesophilic Organisms. Although standard methods or culture media have not been universally adopted by laboratories for the examination of sugar for mesophilic organisms, this laboratory began the examination of the composite samples for members of this group in 1939, employing techniques

TABLE III

COMPOSITE SAMPLES OF SUGAR BEETING CANNING-GRADE SPECIFICATIONS

Campaign Year	Number Samples Tested	Number Samples Passed	Per Cent Samples Passed
1946	77	70	90.9
1945	70	62	88.5
1944	69	61	88.4
1943	65	61	93.8
1942	87	83	95.4
1941	87	77	88.5
1940	87	81	93.1
1939	75	65	86.7
1938	77	74	96.1
1937	70	65	92.9
1936	70	59	84.3
1935	65	47	72.3
1933	58	39	67.2

and media which previous experience indicated would meet its needs. Suggestions as to the numbers of organisms, including aerobic bacteria, yeasts and molds, in sugars for specific uses have been made, and the quality of the composite samples has been judged accordingly. The methods for determining these organisms and the suggested standards were given in the report issued last year but are repeated for convenience.

Aerobic Bacteria. Twenty grams of sugar is weighed aseptically into a sterile 150-ml. Erlenmeyer flask marked to indicate a volume of 100 ml. Sterile distilled water is added nearly to mark. The sugar is dissolved by gentle shaking, and the volume is made up to 100 ml. Five ml. of the solution, containing one gram of sugar, is distributed through 5 Petri dishes which are then poured with Bacto dextrose-tryptone agar containing brom-cresol-purple indicator. The plates are incubated at 30° C. for 48-72 hours before being counted. Acid-forming organisms are identified by the production of a yellow zone around the colony, similar to that described for flat-sour type of thermophiles. The number of acid-forming organisms is combined with the number of non-acid types to obtain the total count.

Yeasts and Molds. Five ml. of the same sugar solution is distributed through 5 Petri dishes as before. The plates are poured with standard wort-agar and are incubated at 30° C. for 5 days before being counted. On account of the relatively small number of yeasts and molds usually present in sugar, difficulty is not often encountered when they are cultured together. Since some types of bacteria are capable of growth on this medium, microscopic examination is made of doubtful colonies for verification as yeasts.

Although standards have not been established for the number of mesophilic organisms in sugar, it has been suggested that the total bacteria

count should not exceed 100 per gram. Almost complete freedom from yeasts and molds is suggested for sugar to be used by the dairy and beverage industries.

The 1946 results of the examination for mesophilic organisms are given in Table I.

There were four samples, or 5.2%, which contained more than 100 mesophilic bacteria per gram of sugar. In 1945 8.5% of the samples contained more than 100 mesophilic bacteria per gram. Although there were fewer samples having total counts in excess of 100 bacteria per gram in 1946, the average bacteria count is 40.1 as compared with 38.4 per gram in 1945 samples. On this basis there is very little difference in the quality of the sugar during the past two years.

Yeasts were detected in only two samples, and the largest number found was two per gram of sugar. Mold contamination was found in 47 samples, or 61.0%, as compared with 78.5% in 1945. The number of colonies varied from one to 311 per gram of sugar. As previously mentioned there are no standards for mold contamination in sugar, so the samples cannot be evaluated on this basis as ingredients of food products. It is believed, however, that when the number of colonies exceeds 5 per gram of sugar, unusual conditions that contribute to mold contamination probably exist within the factory and measures should be taken to locate their source. It is significant that apparently pure cultures of molds were found in some samples. This is an indication that contamination originated from some localized point in the process, rather than from air borne contamination, which usually introduces a variety of molds.

In summarizing the results of the bacteriological examination of the

1946 sugar, and evaluating its overall quality in comparison with sugar manufactures in 1945, it may be seen that there was a slight improvement from the standpoint of contamination with thermophilic bacteria. Although there was an increase of 2.4% in samples meeting the specifications for canning-grade sugar, perhaps more significant is the reduction of the average total aerobic thermophilic bacteria from 45.4 per 10 grams last year to 25.4 per 10 grams this year. As previously noted there is very little difference in the quality when based on mesophilic organisms.

EXAMINATION FOR YEAST GROWTH-PROMOTING SUBSTANCES

The composite samples were again examined for the presence and relative amount of substances which promote the growth of yeasts in solutions of the sugar. Information regarding the identification of these substances, their significance in beverages, and methods for estimating and reporting the relative amount in each sample was reviewed in the 1942 and 1943 campaign reports (Mimeographed Circulars AIC-29 and AIC-62, respectively). During the course of the study on various phases of this subject three technical papers have been published. They are listed for further reference, as follows:

Yeast Growth Stimulants in White Sugars, by H. H. Hall, L. H. James and L. S. Stuart. Indus. and Engin. Chem., 25, 1052-1054. (1933).

Crystal Surface Contaminants and Biological Quality of Sugar, by H. H. Hall and L. H. James. Facts About Sugar. 31, pp. 222-223. (1936).

A Study of Yeast Growth-Promoting Substances in White Sugar, by H. H. Hall, H. S. Paine and F. W. Fabian. Food Research. 12, No. 2, pp. 99-110 (1947).

RESULTS

The results of the examination of the samples for yeast growth-promoting substances are given in Table IV in which the samples are

arranged in numerical order of increasing yeast-inoculum multiple values. For your immediate information, the yeast-inoculum multiple is obtained by dividing the number of yeast cells per ml. after 72 hours' incubation at 30° C. by the number introduced into the sample. The value 1.0 means that there was no multiplication of cells and that yeast growth-promoting substances are considered to be absent when determined by this method. The samples are ranked according to the yeast inoculum multiple values.

The range of yeast-inoculum multiple values is from 1.0 to 30.3. All of the samples are considered to be well within the safe limits for use in the manufacture of beverages.

TABLE IV

RANK OF 1946 COMPOSITE SUGAR SAMPLES ON BASIS OF RELATIVE FREEDOM FROM YEAST GROWTH-PROMOTING SUBSTANCES

Sample No.	Rank	Yeast-Inoculum Multiple	Sample No.	Rank	Yeast-Inoculum Multiple
4603	1	1.0	4694	22	6.1
4606A	1	1.0	4673	23	6.6
4627	1	1.0	4613	24	6.9
4659	1	1.0	4656B	24	6.9
4663	1	1.0	4671	24	6.9
4684	2	1.1	4615	25	7.1
4649	3	1.3	4624	25	7.1
4605	4	1.5	4626	25	7.1
4631	5	1.8	4620	26	7.3
4683	5	1.8	4675	27	7.4
4650	6	1.9	4602	28	7.6
4610	7	2.1	4664	28	7.6
4617	7	2.1	4672	29	8.1
4656A	8	2.3	4642	30	8.4
4657	8	2.3	4668	30	8.4
4618	9	2.4	4652	31	8.5
4621	10	2.6	4641	32	9.0
4607	11	3.4	4616	33	9.2
4678	11	3.4	4623	34	9.4
4643	12	3.7	4637	34	9.4
4665	12	3.7	4655	34	9.4
4632	13	3.9	4654	35	9.8
4660	13	3.9	4661	35	9.8
4640	14	4.0	4625	36	10.2
4647	14	4.0	4630	36	10.2
4601	15	4.4	4633	36	10.2
4646	15	4.4	4634	36	10.2
4622	16	4.7	4608	37	10.3
4606B	17	4.8	4645	38	10.5
4628	18	5.2	4677	39	11.5
4651	18	5.2	4695	40	12.7
4682	18	5.2	4662	41	14.7
4611	19	5.6	4629	42	15.0
4676	19	5.6	4635	43	16.1
4609	20	5.8	4669	44	16.8
4614	20	5.8	4604	45	18.1
4680	20	5.8	4679	46	19.0
4666	21	6.0	4812	47	30.3
4653	22	6.1			

HHHall:DJTeunisson:LW
6/11/47